

# Altair

Subject: 9th BIOLOGY

Topic:

Cellular Respiration

Date: September 9th  
2011



Teacher's notes

Objectives

Vocabulary

Link and Learn

Prepared by

# KEY DEFINITIONS

**Catabolism**: The sum of all the metabolic processes by which complex molecules are broken down to simpler ones, including the processes by which molecules are broken down to yield cellular energy.

**Anabolism**: The sum of all the metabolic processes by which complex biomolecules are built up from simpler ones. In general, these processes consume rather than produce cellular energy.

**Intermediary Metabolism**: All reactions concerned with storing and generating metabolic energy and with using that energy in biosynthesis of low-molecular weight compounds and energy storage compounds. Not included are nucleic acid and protein biosynthesis from monomeric precursors.

**Aerobic Organisms**: Organisms that use oxygen.

**Anaerobic Organisms**: Organisms that do not require oxygen to survive. Some of these organisms will die if placed in an oxygen environment.

**Metabolism**: The totality of the chemical reactions that occur in an organism

**Autotrophs**: Organisms that synthesize glucose and all of their other organic compounds from inorganic carbon, supplied as CO<sub>2</sub> (e.g., most plants).

**Heterotrophs**: Organisms that can synthesize their organic metabolites only from other organic compounds, which they must therefore consume (e.g., animals).

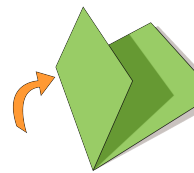
# **OPTIONAL ASSIGNMENT 1**

**Prepare a description of the diseases that can be caused by mitochondrial defects or misfunctions.**

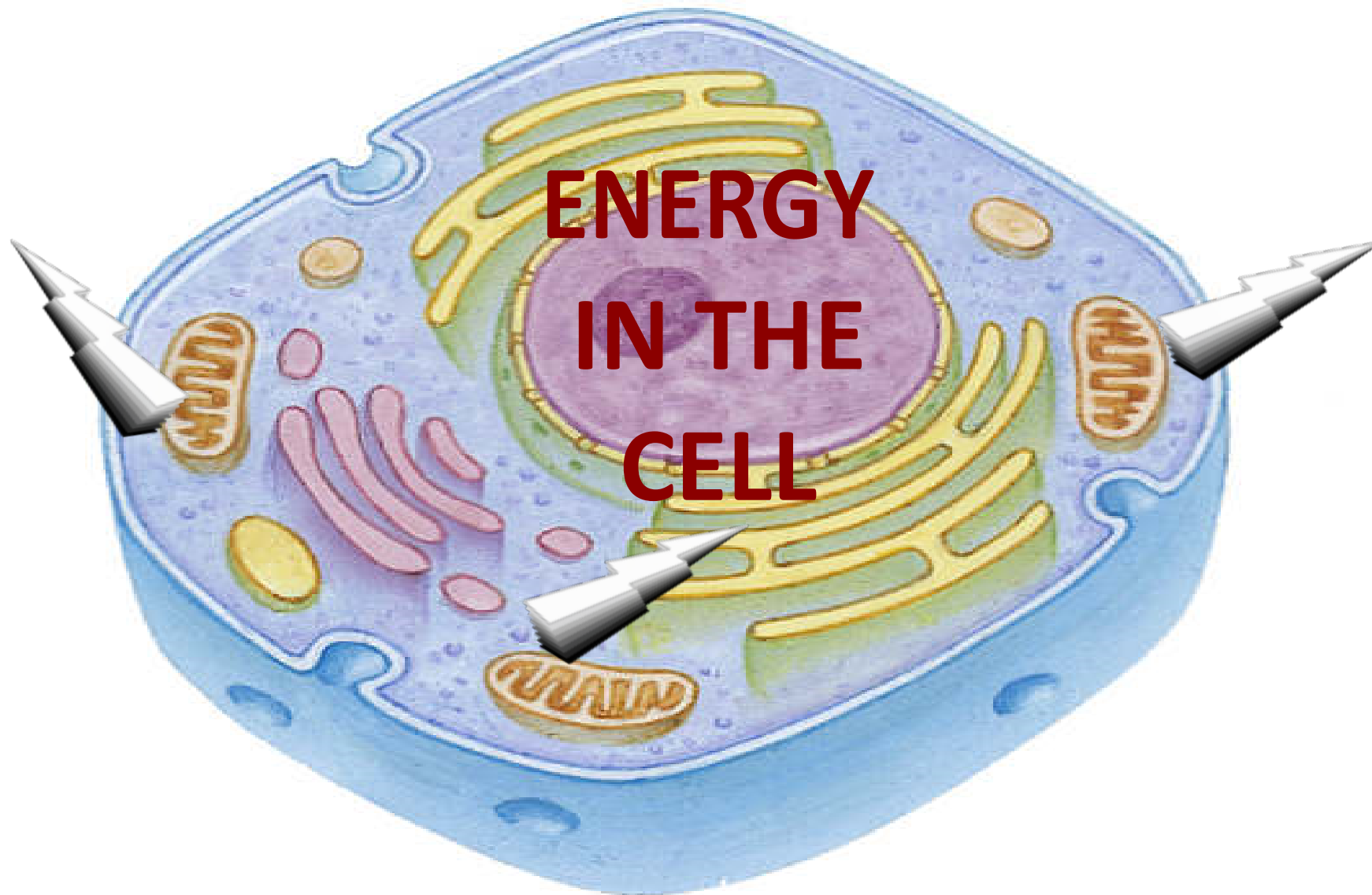


# **OPTIONAL ASSIGNMENT 1**

**Prepare a Prezi presentation about the origin of eukaryotic based on the article "The Birth of Complex Cells" and other sources of information.**

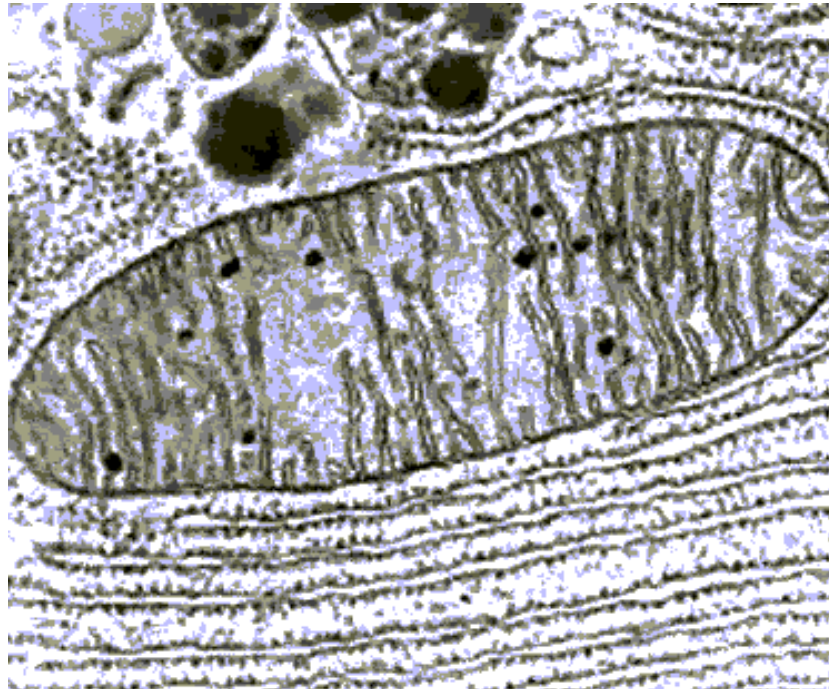


**[Click here for the Article](#)**



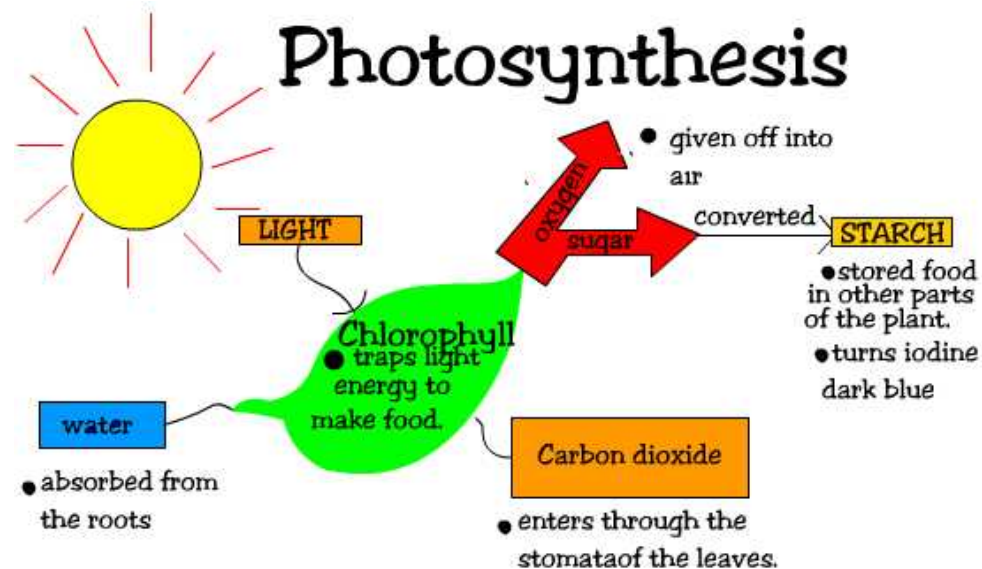
# Energy in Cells

- Living things need energy in order to stay in good state, repair, or maintain their *homeostasis*, or the order and balance when the environment changes.
- Every organism must maintain homeostasis as long as it lives.
- Therefore, organisms require a constant source of energy.



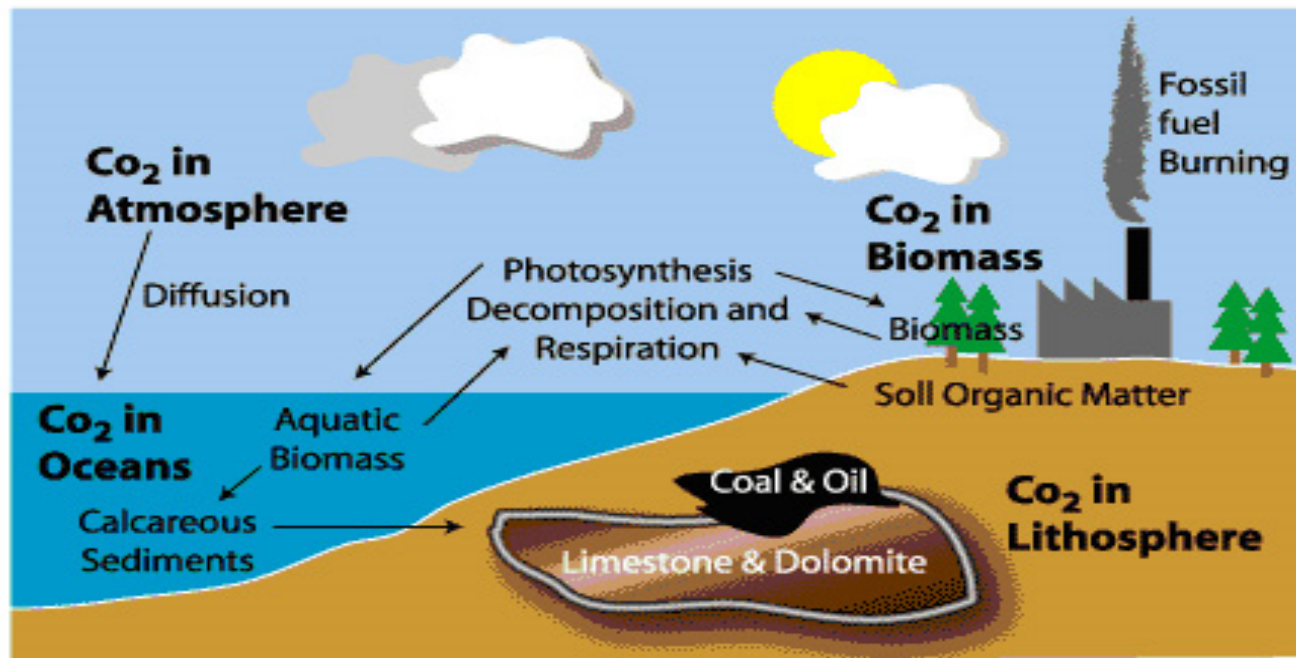
# Chemical Energy

- Organisms use and store energy in the chemical bonds of organic compounds.
- Almost all of the energy in organic compounds comes from the sun.
- Solar energy enters living systems when plants, algae, and certain prokaryotes (Cyanobacteria) use sunlight to make organic compounds from carbon dioxide and water through the process of *photosynthesis*.
- The organisms that perform photosynthesis, are called *autotrophs*.



# Metabolism and the Carbon Cycle

- *Metabolism* involves either using energy to build or breaking down organic molecules in which energy is stored.
- Organic molecules contain carbon. Therefore, an organism's metabolism is part of Earth's carbon cycle.





# Carbon Cycle

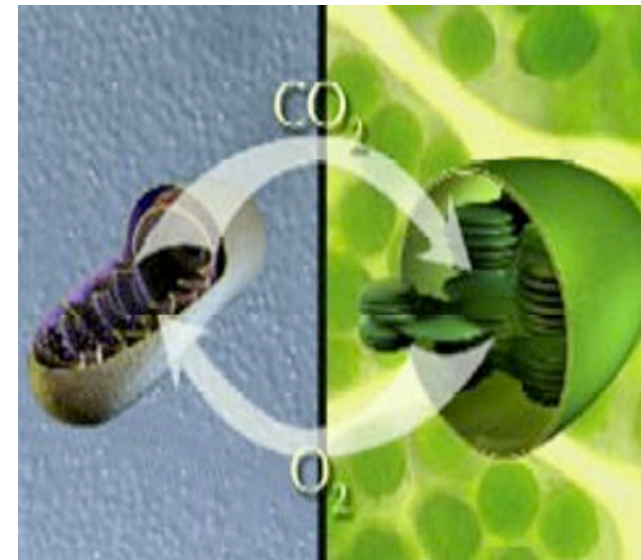
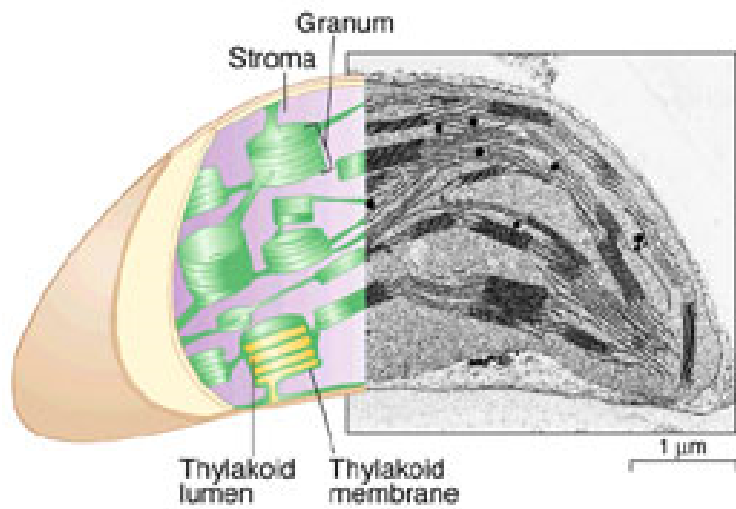
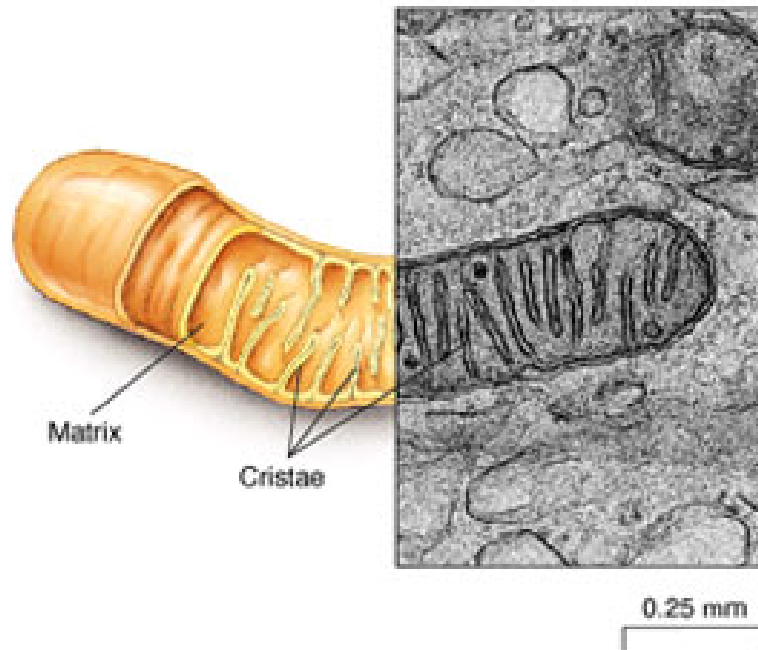
- The Carbon cycle not only makes carbon compounds continuously available in an ecosystem but also delivers chemical energy to organisms living within that ecosystem.

## PHOTOSYNTHESIS

Energy enters an ecosystem when organisms use sunlight during photosynthesis to convert stable carbon dioxide into glucose, a less stable carbon compound.

## CELLULAR RESPIRATION

Organisms extract energy stored in glucose through the process of cellular respiration. Cells convert the carbon in glucose into stable carbon dioxide and produce energy.



# ANIMATION

## Photosynthesis

<http://goo.gl/Ynfdp>

# ANIMATION

## Cellular Respiration

<http://goo.gl/xuhLT>

# Transferring Energy

- In chemical reactions, energy can be released or absorbed during the breaking and forming of bonds.
- In cells, chemical energy is gradually released in a series of chemical reactions that are assisted by enzymes.
- *Enzymes* are proteins that act as catalysts in biochemical reactions.



# ATP

- When cells break down food molecules, some of the energy in the molecules is released as heat. Cells use much of the remaining energy to make ATP (Adenosyl TriPhosphate).
- When glucose is broken down during cellular respiration, energy is stored temporarily in molecules of ATP.
- ATP can be used to power chemical reactions. ATP is a portable form of energy ("energy coin").
- The reaction in which ATP is converted to ADP requires a small input of energy, but much more energy is released than is used during the reaction.



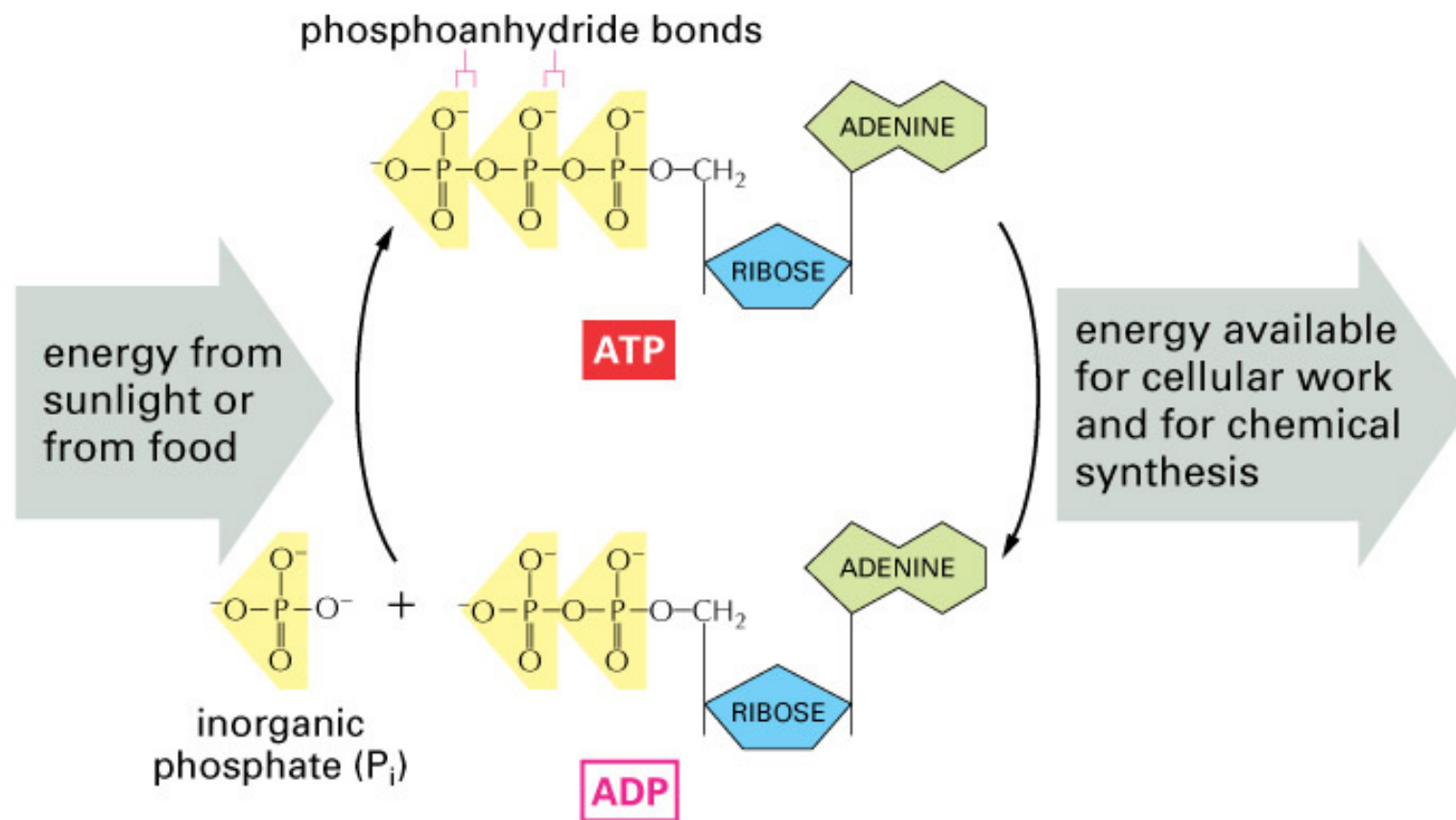
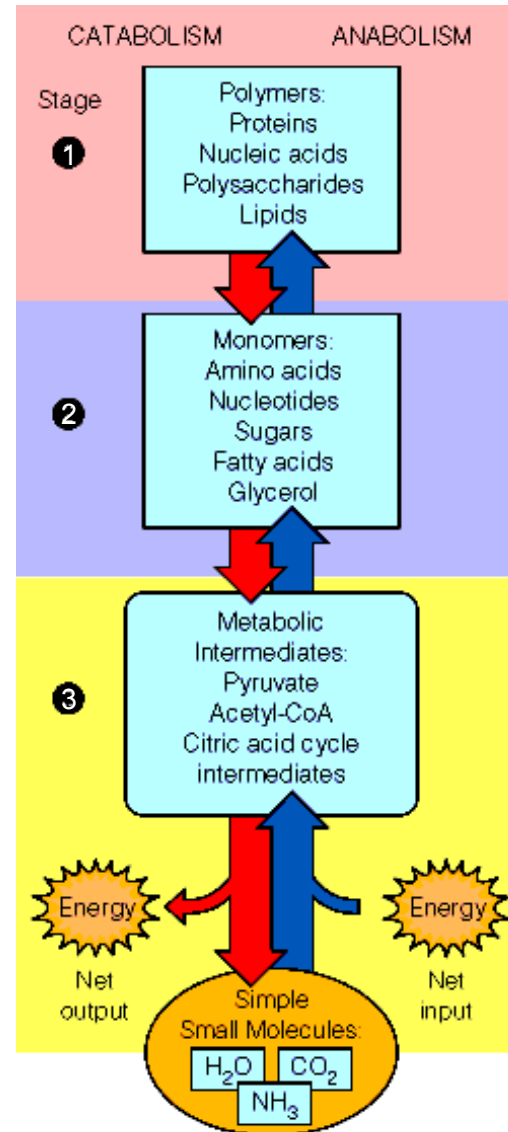
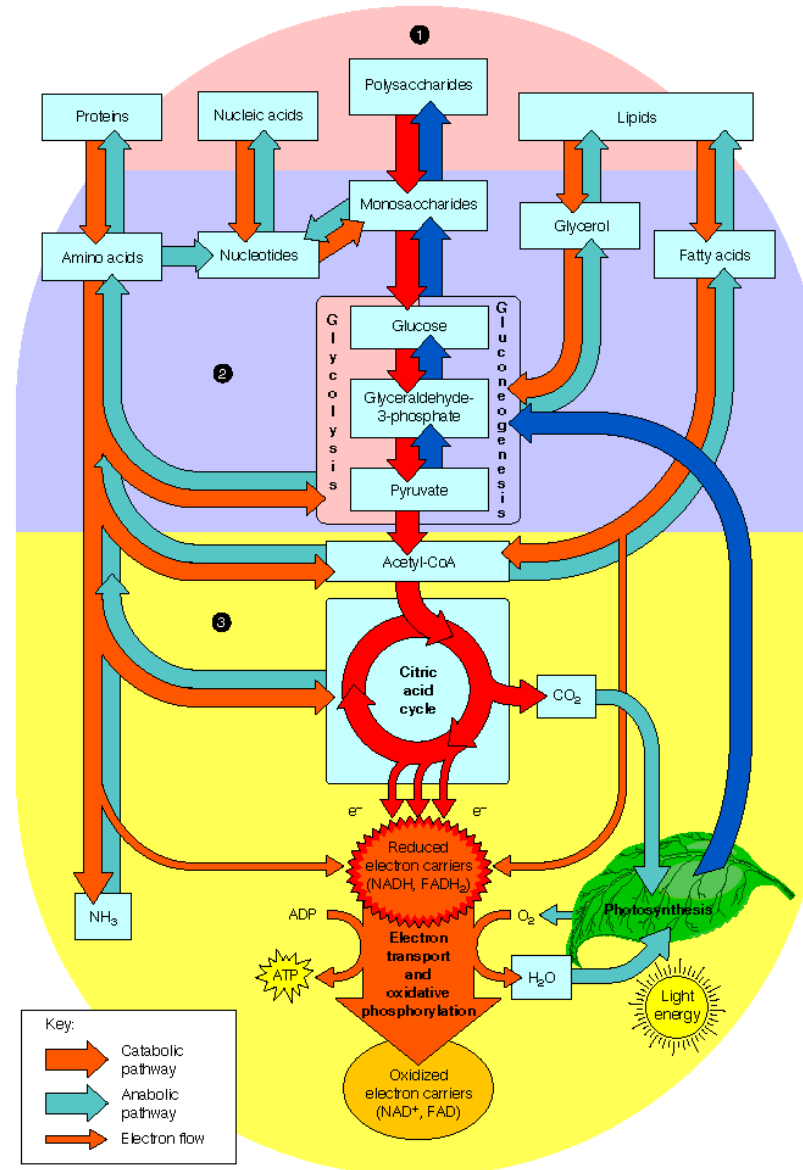
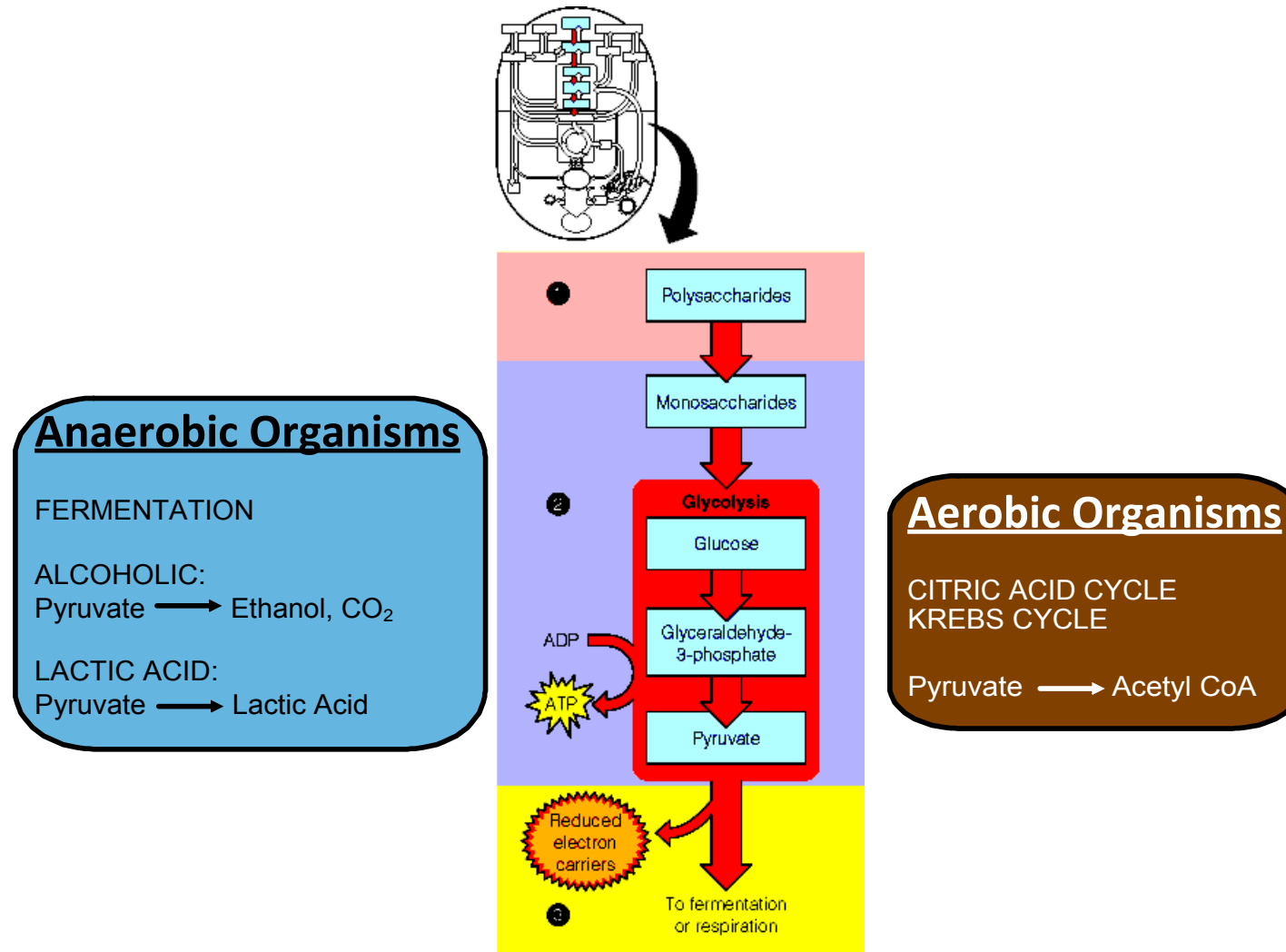


Figure 3-32 Essential Cell Biology, 2/e. (© 2004 Garland Science)

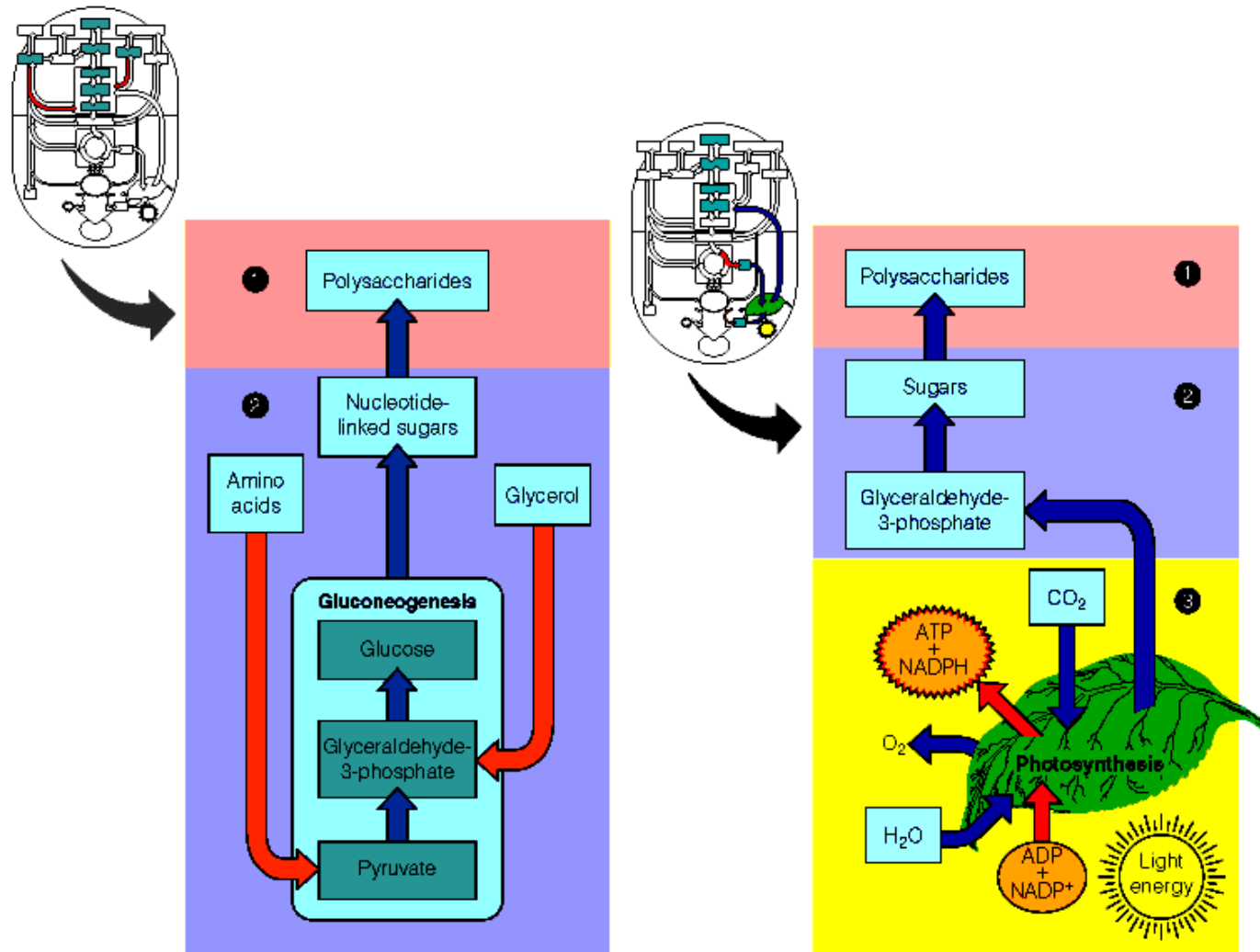






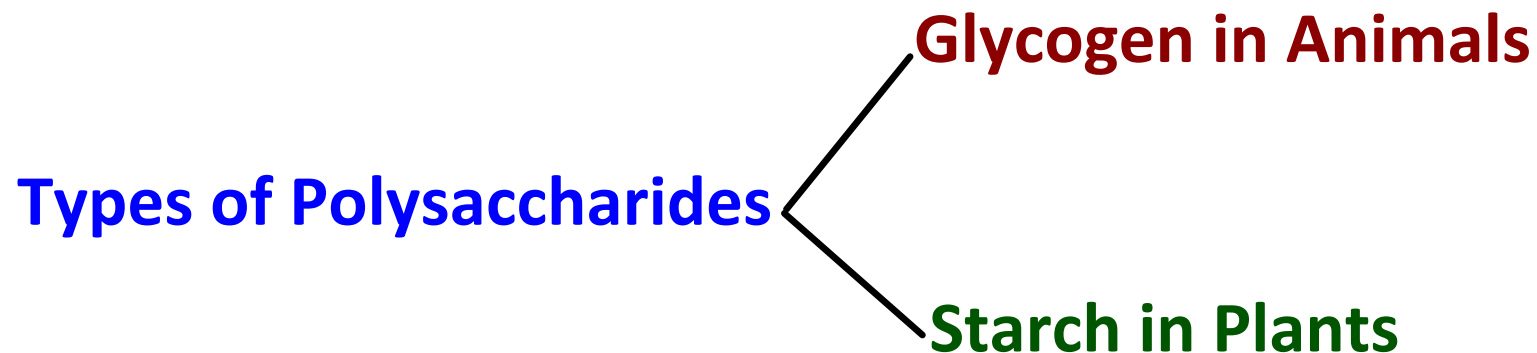


## GLUCOSE METABOLISM



# GLYCOLYSIS

- The primary fuel for cellular respiration is glucose, which is formed when carbohydrates are broken down, such as: starch and sucrose.
- If carbohydrates are scarce to meet an organism's energy needs, other molecules, such as fats, can be broken down to make ATP.
- In fact, fat releases more energy than carbohydrates do.
- Glycolysis has 3 steps: *Breaking down Glucose, NADH Production and Pyruvate Production.*



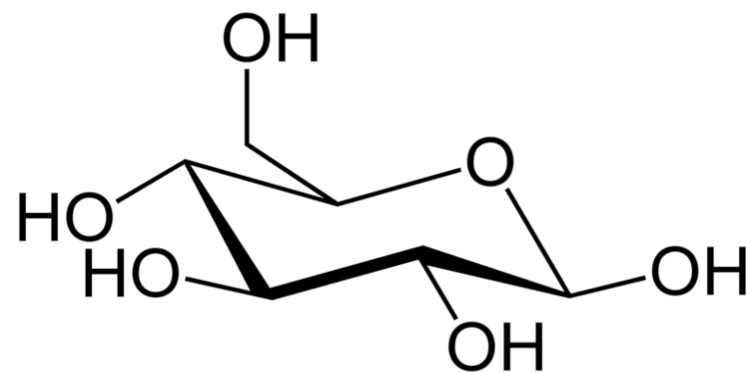
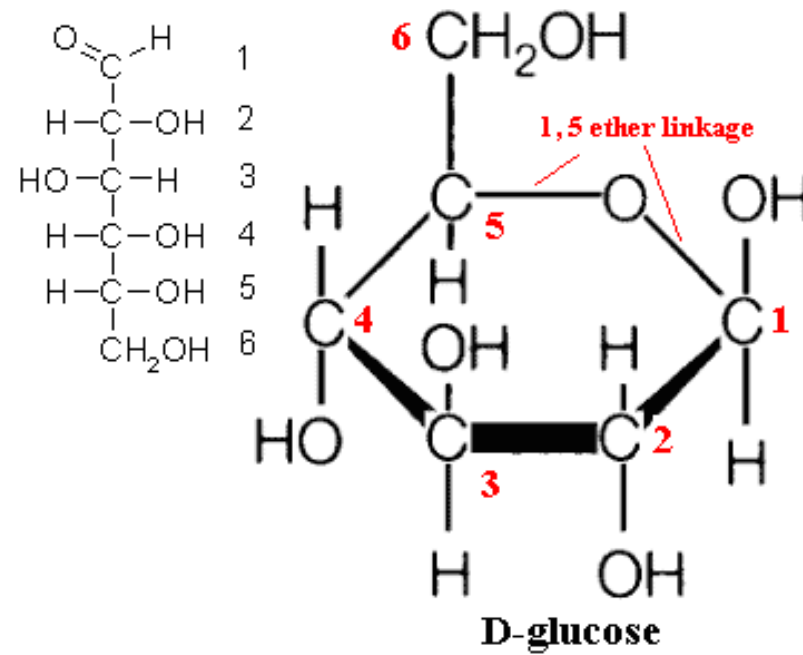
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ANIMATION

Glycolysis

[www.johnkyrk.com](http://www.johnkyrk.com)



# ANIMATION

## Glucose in Water

<http://goo.gl/gvDmr>





# **CELLULAR RESPIRATION**

ANIMATION

Cellular Respiration Overview

<http://goo.gl/J5zJU>

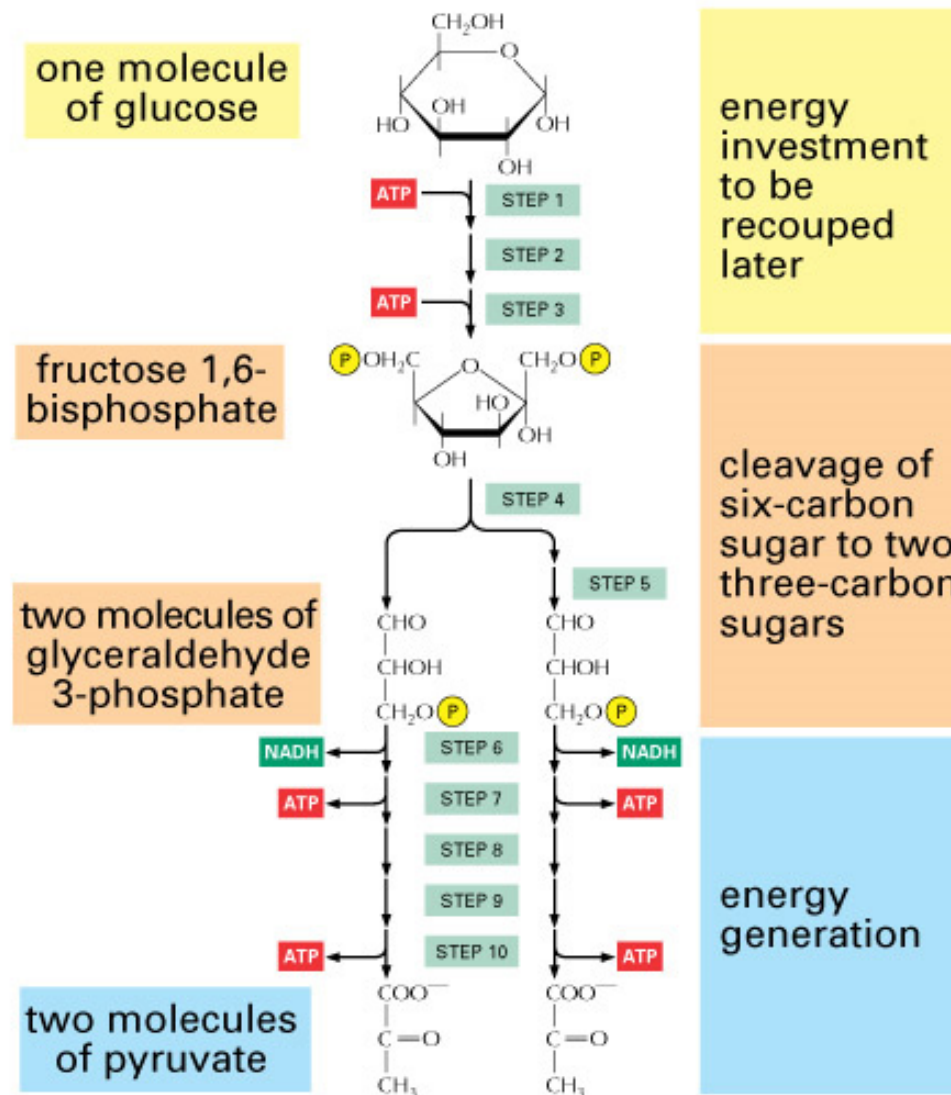


Figure 13-3 Essential Cell Biology, 2/e. (© 2004 Garland Science)

# GLYCOLYSIS

## ANIMATION

Glycolysis: Step by Step

<http://goo.gl/U559F>

<http://bit.ly/9X5jnT>

ANIMATION

Glycolysis: John Kyrk

<http://goo.gl/qHJjx>

## Carbohydrate Metabolism

# Glycolysis

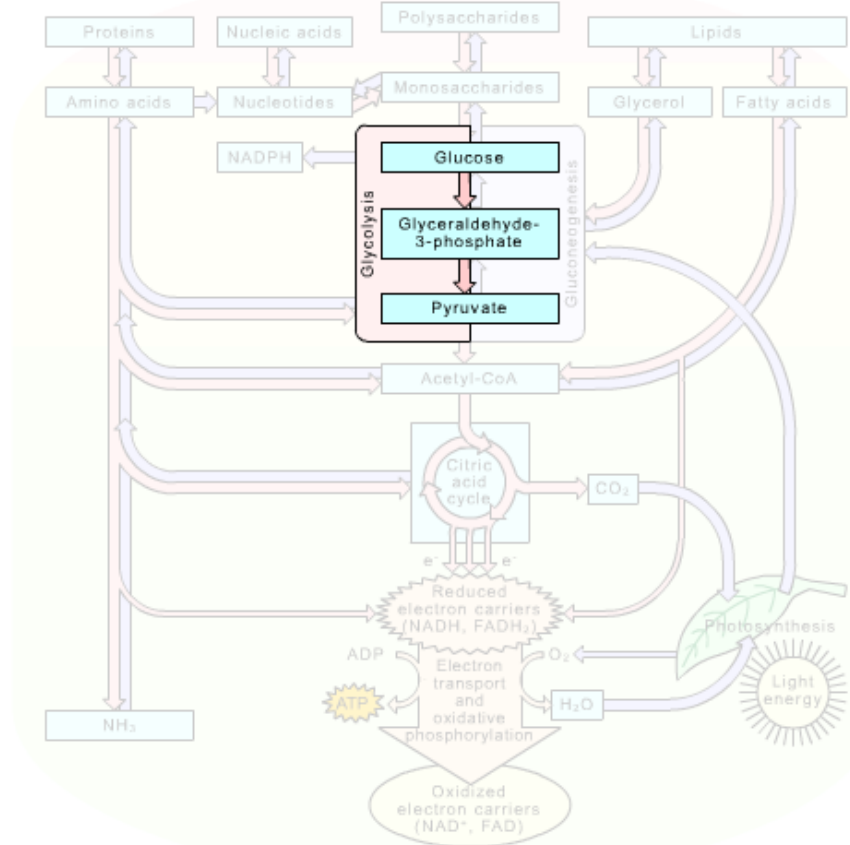
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Introduction

Overview

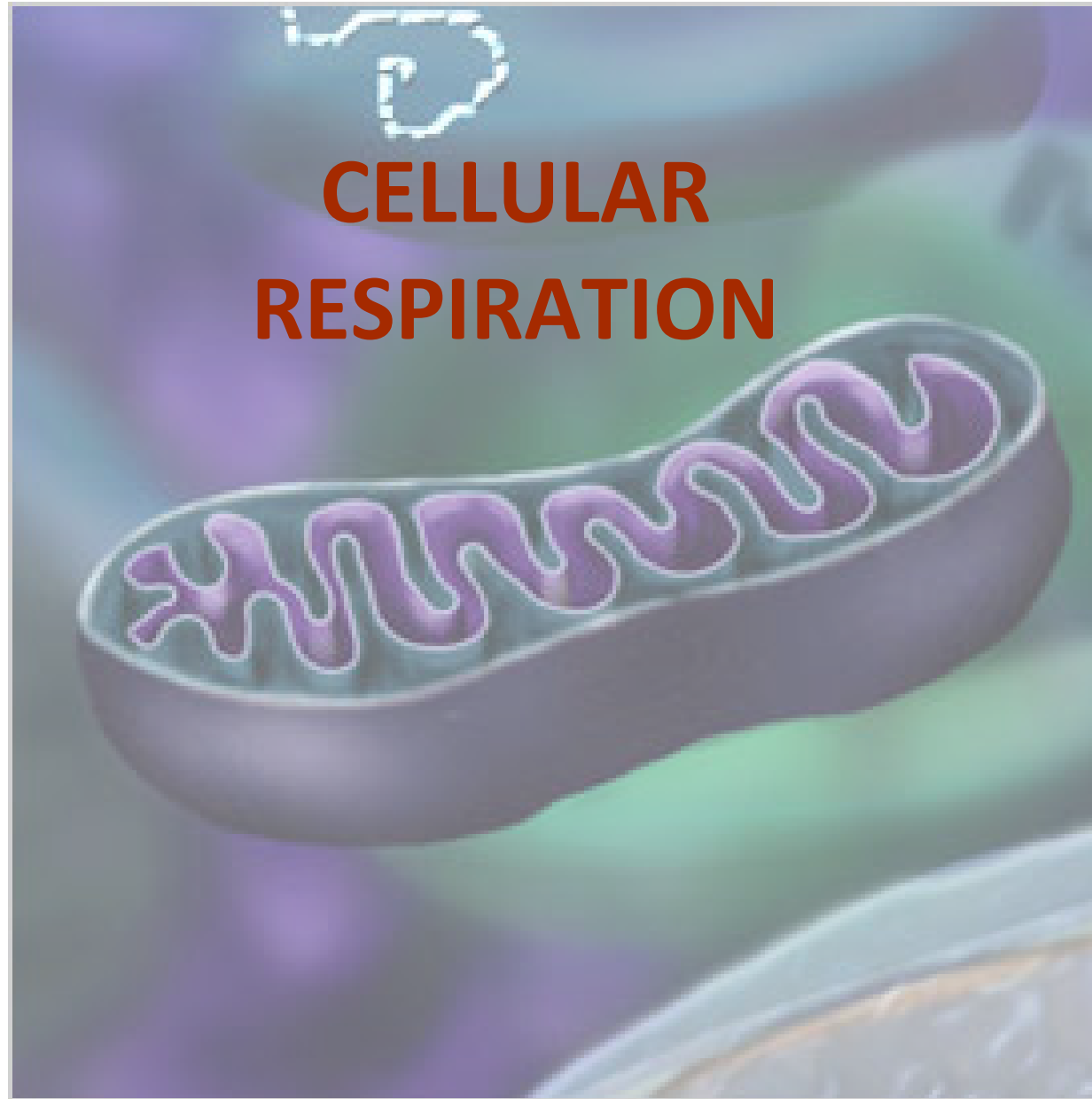
Reaction  
Details

Summary



**Glycolysis** is a central metabolic pathway involving metabolism of the sugar **glucose**. Glucose is usually derived from the energy storage polysaccharides (glycogen) or dietary carbohydrates. Reactions of glycolysis occur solely in the **cytosol** of the cells.

Self Quiz



# ANIMATION

## Electron Transport Chain

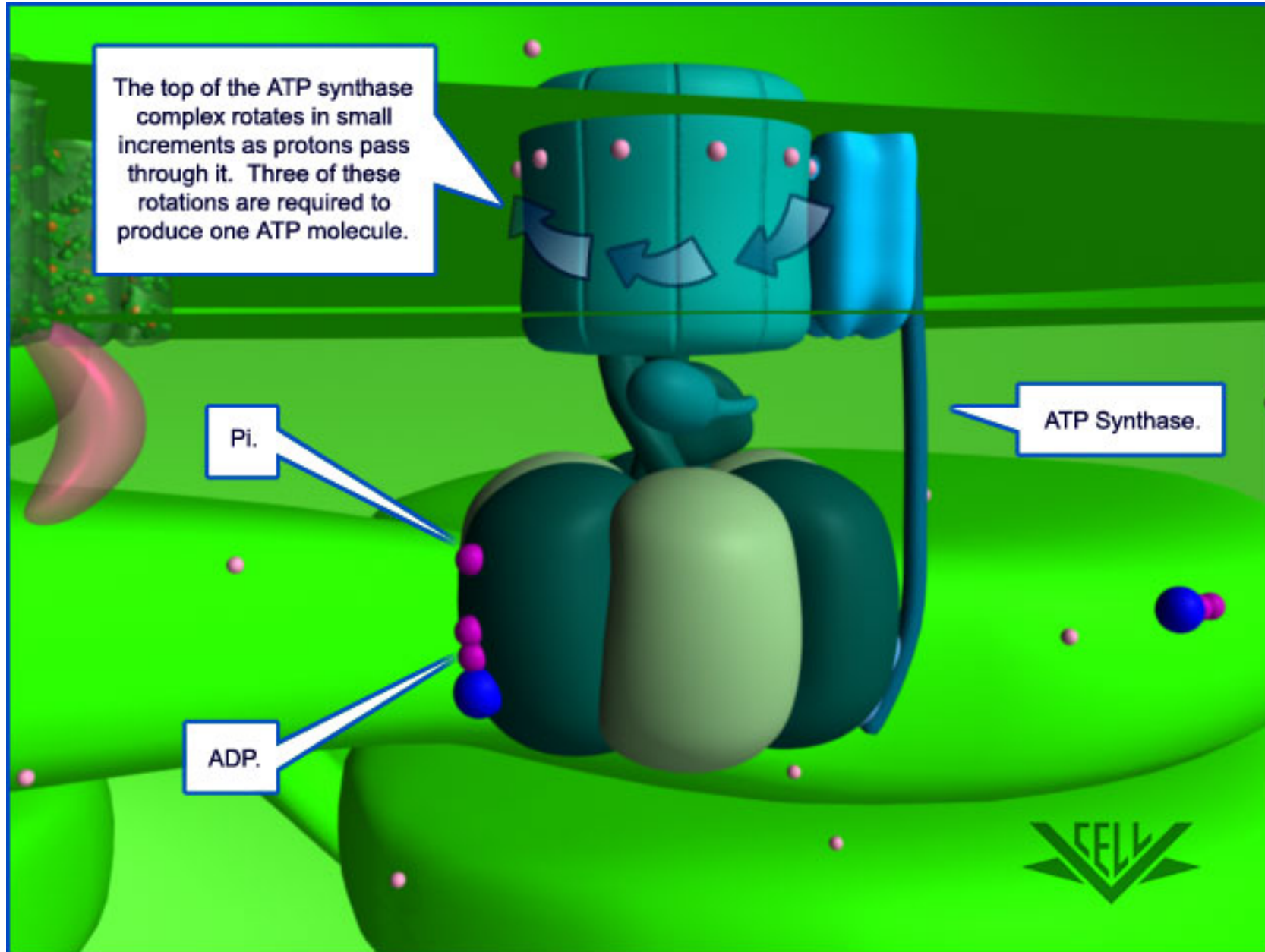
<http://goo.gl/lmoyV>

VIDEO  
Electron Transport Chain  
<http://bit.ly/9JludJ>



# ATP Synthase

- *ATP Synthase* is an enzyme that catalyzes the synthesis of ATP, recycles ADP by bonding a third phosphate group to the molecule.
- ATP Synthase acts as both an enzyme and a carrier protein for hydrogen ( $H^+$ ) ions.
- The flow of  $H^+$  ions through ATP Synthase powers the production of ATP.
- Atp Synthase catalyzes a reaction in which a phosphate group is added to a molecule of ADP to make ATP.

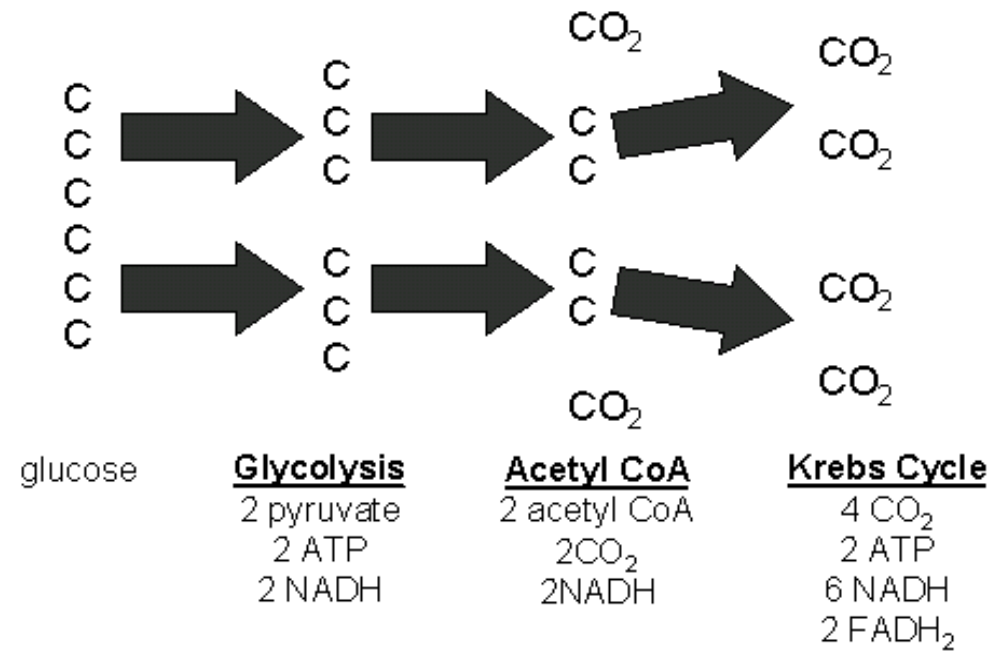


<http://goo.gl/K74LO>

VIDEO  
ATP Synthase  
<http://goo.gl/T9JxI>

# REVIEW

## Summary of Glycolysis and Cellular Respiration

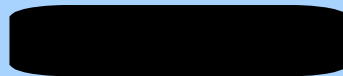


Pathway	Substrate-Level Phosphorylation	Oxidative Phosphorylation	Total ATP
Glycolysis	2 ATP	2 NADH = 4 - 6 ATP*	6 - 8*
CoA		2 NADH = 6 ATP	6
Krebs Cycle	2 ATP	6 NADH = 18 ATP 2 FADH <sub>2</sub> = 4 ATP	24
<b>TOTAL</b>	<b>4 ATP</b>	<b>32 ATP</b>	<b>36 - 38</b>



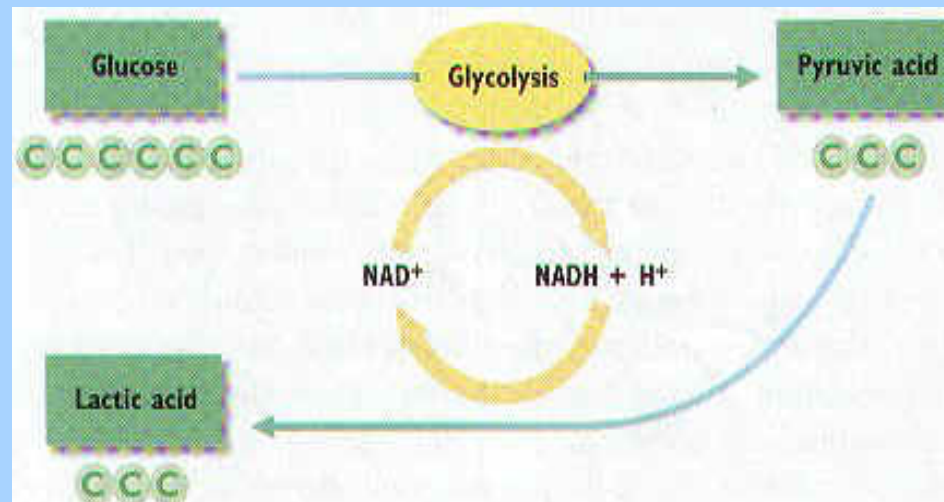
# FERMENTATION

- Many prokaryotes live entirely on the energy released in glycolysis.
- ➡ • Glycolysis produces 2 ATP molecules and one molecule of the electron carrier NADH, which must be able to transfer its electrons to an acceptor so that  $\text{NAD}^+$  is continuously available.
- Under anaerobic conditions, the electron transport chain does not work.
- ➡ • Organisms must have another way to recycle  $\text{NAD}^+$ .
- The process in which carbohydrates are broken down in the absence of oxygen, called \_\_\_\_\_, recycles the  $\text{NAD}^+$  that is needed to continue making ATP through glycolysis.



# Lactic Acid Fermentation (LAF)

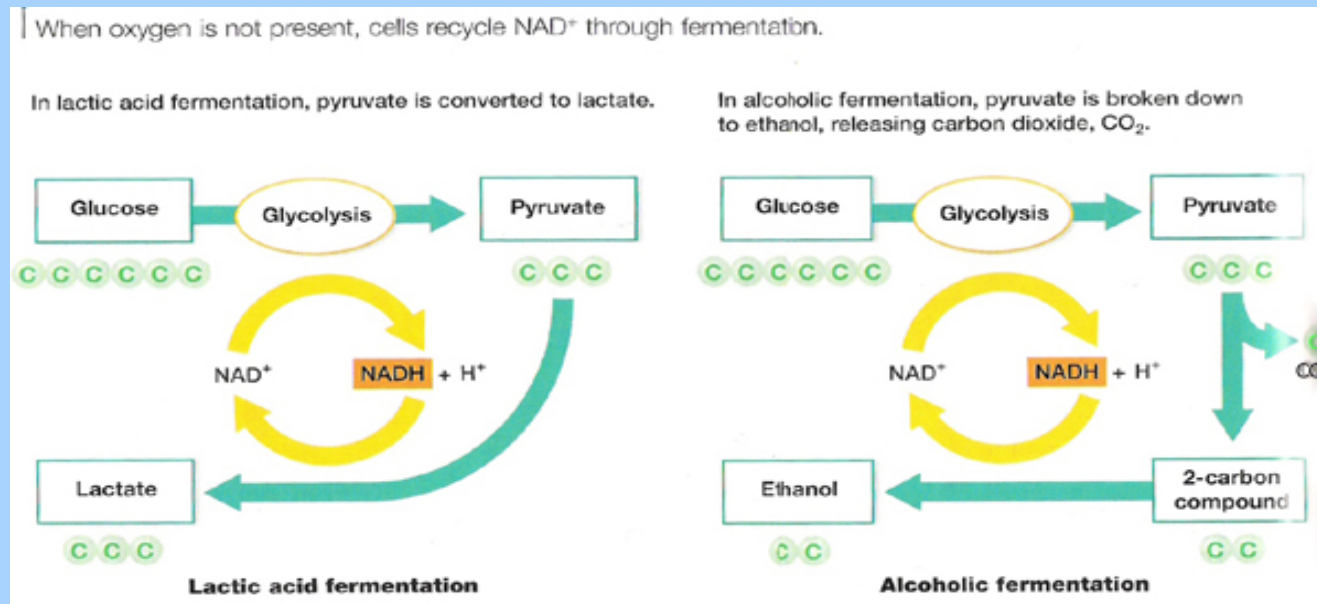
- The end products of glycolysis are 3 carbon pyruvate molecules, which is converted to lactic acid.
- LAF occurs in the muscles of animals, including humans.
- During vigorous exercise, muscle cells must operate without enough oxygen.
- So, glycolysis becomes the only source of ATP as long as the glucose supply lasts.





# Alcoholic Fermentation (AF)

- In other organisms, an enzyme removes carbon dioxide from the 3-carbon pyruvate to form a 2-carbon molecule.
- Then, a second enzyme adds electrons and hydrogen from NADPH to the molecule to form ethanol.
- In this process,  $\text{NAD}^+$  is recycled and glycolysis can continue to produce ATP.



<http://bit.ly/ZSfq9>





# ANIMATION

## Metabolic Pathways

<http://goo.gl/2VoD3>



ANIMATION  
How the Krebs Cycle works  
<http://goo.gl/FLdDJ>

# DECOMPOSITION

VIDEO

Decomposition

<http://goo.gl/ZOZWN>

## Additional Links

[http://www.sci.uidaho.edu/bionet/biol115/t4\\_energy/lesson1.htm#Glycolysis](http://www.sci.uidaho.edu/bionet/biol115/t4_energy/lesson1.htm#Glycolysis)



<http://www.wiley.com/legacy/college/boyer/0470003790/animations/animations.htm>



<http://nhscience.lonestar.edu/biol/glylysis/glylysis.html>



<http://www.ruf.rice.edu/~bioslabs/studies/mitochondria/mitopoisons.html>



<http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/C/CellularRespiration.html>



# Teacher's Notes

This class has been designed to cover the topic of *Cellular Respiration* from Monday, September 5th till Friday, September 9th.

For further knowledge about this topic:

1. Conduct a thorough search under the topic: *Cellular Respiration* on the Web, books and magazines.
2. If findings are not specific, ask your teacher for suggestions.

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# Objectives

## ***General***

- Understand the intricate processes of Glycolysis and Cellular Respiration.
- Identify the factors affecting positively and negatively in the Glycolysis and Cellular respiration processes.

***Note:*** All, or most, of the objectives will be covered during class time, however the student must be responsible for those objectives not covered or concluded.

# BACK

# Vocabulary

- Glucose:
- Anabolism:
- Catabolism:
- Metabolism:
- Poison:
- Cyanide:

***Note:** Most of the vocabulary words will be covered during class time, however the student must be responsible for those words not covered or concluded.*

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# Link and Learn

**You can visit the following websites to improve your understanding on the present topic:**

- <http://science-altair.wikispaces.com>
- <http://learningandscience.blogspot.com>

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The Birth of Complex Cells - SciAm - 1996.pdf